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(54) Title: SYSTEM AND METHOD FOR USING A GLOBAL TRANSLATOR TO SYNCHRONIZE WORKSPACE ELEMENTS ACROSS A NETWORK  
 (54) Titre: SYSTEME ET PROCEDE D'UTILISATION D'UN TRADUCTEUR GLOBAL POUR SYNCHRONISER DES ELEMENTS D'UNE ZONE DE MANOEUVRE A TRAVERS UN RESEAU

**(57) Abstract**

A system (100) uses a global translator (122) to automatically synchronize multiple copies of a workspace element across different format between multiple sites in a secure network environment, independent of whether the sites are protected by site firewalls (114). The secure network environment includes a global server (106) connected to multiple clients. The system includes a first store (136) for storing a first workspace element in a first format, a second store (154) for storing a workspace in a second format, a communication channel (108) coupling the first store to the second store, and a translator (122) for translating between a first format and second format.

**(57) Abrégé**

Un système (100) utilise un traducteur global (122) pour synchroniser automatiquement des copies multiples d'un élément de zone de manœuvre de largeurs de format différentes entre des sites multiples dans un environnement de réseau sûr, indépendamment du fait que les sites soient protégés par des murs coupe-feu (114) du site. L'environnement de réseau sûr comprend un serveur global (106) connecté à des clients multiples. Le système comprend une première mémoire (136) pour la mémorisation d'un premier élément d'une zone de manœuvre dans un premier format, une deuxième mémoire (154) pour la mémorisation d'une zone de manœuvre dans un deuxième format, un canal de communication (108) reliant la première mémoire à la deuxième mémoire, et un traducteur (122) assurant la traduction entre un premier format et un deuxième format.

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(54) Title: <b>SYSTEM AND METHOD FOR USING A GLOBAL TRANSLATOR TO SYNCHRONIZE WORKSPACE ELEMENTS ACROSS A NETWORK</b>		
(57) Abstract		
<p>A system (100) uses a global translator (122) to automatically synchronize multiple copies of a workspace element across different format between multiple sites in a secure network environment, independent of whether the sites are protected by site firewalls (114). The secure network environment includes a global server (106) connected to multiple clients. The system includes a first store (136) for storing a first workspace element in a first format, a second store (154) for storing a workspace in a second format, a communication channel (108) coupling the first store to the second store, and a translator (122) for translating between a first format and second format.</p>		

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**Description**

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SYSTEM AND METHOD FOR USING A GLOBAL TRANSLATOR TO SYNCHRONIZE  
WORKSPACE ELEMENTS ACROSS A NETWORK

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BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to computer networks, and more particularly to a system and method for using a global translator to synchronize workspace elements such as files across a computer network.

2. Description of the Background Art

20 Data consistency is a significant concern for computer users. For example, when maintaining multiple independently-modifiable copies of a document, a user risks using an outdated version. By the time the user notices an inconsistency, interparty miscommunication or data loss may have already resulted. The user must then spend more time attempting to reconcile the inconsistent versions and addressing any miscommunications.

30 The problem of data inconsistency is exacerbated when multiple copies of a document are maintained at different network locations. For example, due to network security systems such as conventional firewall technology, a user may have access only to a particular one of these network locations. Without access to the other sites, the user cannot confirm that the version on the accessible site is the most recent draft.

40 Data consistency problems may also arise when using application programs from different vendors. For example, the Netscape Navigator™ web browser and the Internet Explorer™ web browser each store bookmarks for quick reference to interesting web sites. However, since each web browser uses different formats and stores bookmarks in different files, the bookmarks are not interchangeable. In addition, one web browser may store a needed bookmark, and the other may not. A user who, for example, runs the Internet Explorer™ web browser at home and runs the Netscape Navigator™ web browser at work risks having inconsistent bookmarks at each location.

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5           Therefore, a system and method are needed for providing users with data consistency,  
and more particularly for synchronizing multiple copies of a workspace element such as a  
document across a computer network.

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SUMMARY OF THE INVENTION

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The present invention provides a system and method for using a global translator to synchronize multiple copies of a workspace element in a secure network environment. The secure network environment includes a global server connected to multiple clients. Using the present system and method, the clients automatically synchronize workspace elements between multiple sites, independent of whether the sites are protected by site firewalls. Using the present system and method, the clients can automatically synchronize workspace elements across different formats and can merge workspace element folders for cross use.

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The system includes a first store for storing first workspace elements in a first format, a second store for storing second workspace elements in a second format, a communications channel coupling the first store to the second store, synchronization means for synchronizing first workspace elements and second workspace elements, and a translator for translating between the first format and the second format.

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Similarly, the method includes the steps of accessing a first store storing a first workspace element in a first format, accessing a second store storing a second workspace element in a second format, synchronizing the first workspace element and the second workspace element, and translating between the first format and the second format.

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The system and method advantageously use a trusted third party to enable the synchronization of workspace data among multiple sites. Accordingly, a client user who maintains a work site, a home site, an off-site and the global server site can synchronize the workspace data or portions thereof among all four sites. Further, the predetermined criteria (which control when the synchronization-start module initiates synchronization) may be set so that the general synchronization module synchronizes the workspace data upon user request, at predetermined times during the day such as while the user is commuting, or after a predetermined user action such as user log-off or user log-on. Because the system and method operate over the Internet, synchronization can occur over any distance. Since the system and method include format translation, merging of workspace elements between different application programs and different platforms is possible. Further, because

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5 synchronization is initiated from within the firewall, the typical firewall which prevents in-  
bound communications does not act as an impediment to workspace element synchronization.  
Also, since the user's preferences may be previously set, the present system and method may  
10 operate unattended by the client user.

BRIEF DESCRIPTION OF THE DRAWINGS

15 FIG. 1 is a block diagram illustrating a computer network in accordance with the  
present invention;

FIG. 2 is a block diagram illustrating details of a FIG. 1 service server;

FIG. 3 is a block diagram illustrating details of the FIG. 1 desktop computer;

20 FIG. 4 is a block diagram illustrating details of a FIG. 1 base system;

FIG. 5 is a block diagram illustrating details of the FIG. 1 synchronization agent;

FIG. 6 is a graphical representation of an example bookmark in the global format; and

25 FIG. 7 is a flowchart illustrating a method for synchronizing multiple copies of a  
workspace element in a secure network.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

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FIG. 1 is a block diagram illustrating a computer network 100, comprising a first node such as a remote computer terminal 102 coupled via a communications channel 104 such as the Internet to a global server 106. The global server 106 is in turn coupled via a communications channel 108 such as the Internet to a second node such as a Local Area Network (LAN) 110. The global server 106 is protected by a global firewall 112, and the LAN 110 is protected by a LAN firewall 114.

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The LAN 110 includes a system bus 126 coupling the LAN firewall 114 to an e-mail server 128 having an e-mail folder 138 containing e-mails, to a file server 132 having a file folder 142 containing files, to a calendar server 130 having a calendar folder 140 containing calendar data, and to a desktop computer 134 having a web browser 152 and a bookmark folder 144 containing bookmarks. It will be appreciated that the e-mail folder 138, file folder 142, calendar folder 140 and bookmark folder 144 or portions thereof may be stored at different locations such as on the desktop computer 134. The e-mail folder 138, file folder 142, calendar folder 140 and bookmark folder 144 are exemplary, grouped by like

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information and are collectively referred to herein as "workspace data" 136. Those skilled in the art will recognize that the workspace data 136 may include other types of data such as an application program such as Microsoft Word 6.0.1 and the documents created using them. It will be further appreciated that the e-mail folder 138, file folder 142, calendar folder 140 and bookmark folder 144 may each be divided into workspace elements, wherein each workspace element folder or each workspace element individually is identified by particular version information 255 (described below with reference to FIG. 2). Accordingly, each e-mail or e-mail folder, file or file folder, calendar or calendar folder, bookmark or bookmark folder, document or document folder, etc. may be referred to as "a workspace element."

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Each workspace element of workspace data 136 in LAN 110 is maintained in a predetermined format, referred to as Format A, which is based on the service engine 245 (FIG. 2) that created it. For example, the web browser 152 on the desktop computer 134 may be the Netscape Navigator™ web browser, and the bookmarks in the bookmark folder 144

5 created thereby are maintained in Format A. Although Format A is being described as a single format, one skilled in the art knows that Format A actually includes a format for each information type, e.g., there will be a Format A for bookmarks, a Format A for files, a Format  
10 A for calendar data, a Format A for e-mails, etc.

15 The remote terminal 102 stores service engines 154 for maintaining workspace data 116, which may include information common with information in the workspace data 136. The workspace data 116 is maintained in a format, referred to as Format B, which may be  
20 different from Format A. Format B is also based on the service engines 154 that create the workspace elements. For example, if one of the service engines 154 is the Internet Explorer™ web browser (not shown), then the bookmarks (not shown) created therewith are maintained in Format B. Although Format B is being described as a single format, one skilled in the art knows that Format B actually includes a format for each information type. Further, the workspace data 116 also includes version information 150 similar to version  
25 information 255 described below with reference to FIG. 2.

30 It will be appreciated that remote terminal 102 may include a smart telephone, a Personal Data Assistant (PDA) such as the PalmPilot system by the U.S. Robotics, Inc., a laptop computer, etc. As a smart telephone, the workspace data 116 may include telephone numbers and e-mails. As a PDA, the workspace data 116 may include addresses, calendar  
35 data and e-mails. As a laptop computer, the workspace data 116 may include the same types of information as workspace data 136.

40 The global server 106 acts as a third party administrator. The global server 106 stores independently-modifiable copies of selected portions of the workspace data 136 and 116, collectively referred to herein as workspace data 120. Accordingly, the workspace data 120 includes an independently-modifiable copy of each workspace element in the selected  
45 portions of the workspace data 136 and 116 and an independently-modifiable copy of each corresponding version information 255 (FIG. 2) and 150. The version information copies are collectively referred to herein as version information 148, and are also described with  
50 reference to FIG. 2.

5                   The global server 106 maintains the workspace data 120 in a format, referred to as a  
"global format," which is selected to be easily translatable by the global translator 122 to and  
from Format A and to and from Format B. Although the global format is being described as a  
10 single format, one skilled in the art knows that the global format actually includes a global  
format for each information type, e.g., there will be a global format for bookmarks, a global  
format for files, a global format for calendar data, a global format for e-mails, etc. An  
15 example bookmark workspace element in the global format is described in detail below with  
reference to FIG. 6.

20                  Network 100 further comprises synchronization means, which includes a base system  
146 stored within the LAN 110 and for example on the desktop computer 134. Network 100  
further includes a synchronization agent 124 stored outside the LAN firewall 114 and  
25 preferably on the global server 106. The base system 146 and the synchronization agent 124  
cooperate to synchronize selected portions of the workspace data 136 with selected portions  
of the workspace data 120. The synchronization means may synchronize workspace elements  
30 individually, e.g., specific word processor documents, or may synchronize workspace element  
folders, e.g., a bookmark folder. Generally, the base system 146 manages the selected portion  
of the workspace data 136 within the LAN 110 and the synchronization agent 124 manages  
the selected portions of the workspace data 120 within the global server 106. It will be  
35 appreciated that the global translator 122 cooperates with the synchronization means to  
translate data formats to and from the global format. As described in greater detail below  
with reference to FIG. 4, the base system 190 preferably initiates and controls data  
40 synchronization.

45                  The synchronization means may also include, stored on the remote terminal 102, a  
base system 118 which operates in a similar manner to the base system 146. The base system  
118 on the remote terminal 102 cooperates with the synchronization agent 124 to synchronize  
selected portions of the workspace data 116 with selected portions of the workspace data 120.  
As described in greater detail below with reference to FIG. 4, the base system 118 on the  
50 remote terminal 102 also preferably initiates and controls data synchronization with the

5 global server 106. Also, note that the distribution of labor between the base system 118 in the remote terminal 102 and the synchronization agent 124 in the global server 106 may vary. Sometimes, primarily when the remote terminal 102 is a relatively less computationally-  
10 powerful device (such as a smart phone or a PDA), most of the actual computationally- intensive work will occur within the synchronization agent 124 in the global server 106. In other situations, for example, when the remote terminal 102 is a fully configured PC, most of  
15 the computationally-intensive work will occur locally on the base system 118 in the remote terminal 102.

Accordingly, the synchronization means independently synchronizes the selected  
20 portions of workspace data 116 and 136 with the selected portions of the workspace data 120. Thus, the synchronization means indirectly synchronizes workspace data 136 with workspace data 116.  
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30 FIG. 2 is a block diagram illustrating details of a service server 200, wherein each of the e-mail server 145, the file server 150, the calendar server 155 and the desktop computer 160 is an instance thereof. Service server 200 includes a Central Processing Unit (CPU) 205 such as an Intel Pentium® microprocessor or a Motorola Power PC® microprocessor. An  
35 input device 210 such as a keyboard and mouse and an output device 215 such as a Cathode Ray Tube (CRT) display are coupled via a signal bus 220 to CPU 205. A communications interface 225 (such as an Ethernet port), a data storage device 230 (such as a magnetic disk), and Random-Access Memory (RAM) 235 are further coupled via signal bus 220 to the CPU  
40 205.

45 An operating system 240 includes a program for controlling processing by the CPU 205, and is typically stored in the data storage device 230 and loaded into the RAM 235 for execution. A service engine 245 includes a program for performing a particular service such as maintaining an e-mail data base, a file data base, a calendar data base or a bookmarks data base. The service engine 245 may also be stored in the data storage device 230 and loaded  
50 into the RAM 235 for execution.

5                   To perform a service, the service engine 245 creates service data 250 (e.g., an e-mail or an e-mail folder 138 containing e-mails, a file or a file folder 142 containing files, calendar data or a calendar folder 140 containing calendar data, a bookmark or a bookmark folder 144 containing bookmarks, etc.) in Format A according to predetermined protocols. The service engine 245 stores the data 250 in the data storage device 250. The service data 250 includes version information 255 indicating the date and time of the last modification and the status as of the last interaction with the global server 106.

10                  For example, if service data 250 is created and selected to be merged with global server workspace data 120, then the version information 255 for the service data 250 may include the date of last modification and a null set indicating the status as of the last interaction with the global server 106. From the version information 255, the base system 146 determines that the service data 250 in its entirety has not been merged with the global server workspace data 120. Similarly, if the service data 255 included elements 1, 2 and 3 as of the last modification, then the previous status as of the last interaction will indicate that the service data 255 included elements 1, 2 and 3. If the service data 255 currently includes elements 2, 3 and 4, then the base system 140 will determine that, since last synchronization, element 1 has been deleted and element 4 has been added.

15                  It will be appreciated that the version information 148 on the global server 106 includes information similar to version information 255. That is, the version information 148 will include information indicating the date and time the version was last modified and the status as of the last interaction with each client. The service engine 245 operates to update the version information 255 after modifications are made and after synchronization occurs.

20                  FIG. 3 is a block diagram illustrating details of the desktop computer 160, which includes a CPU 305, an input device 310, an output device 315, a communications interface 325, a data storage device 330 and RAM 335, each coupled to a signal bus 320.

25                  An operating system 340 includes a program for controlling processing by the CPU 305, and is typically stored in the data storage device 330 and loaded into the RAM 335 for

5 execution. A web browser 152 (i.e., a particular service engine 245, FIG. 2) includes a Format A service program for managing bookmark folder 144 (i.e., particular service data 250, FIG. 2) which includes version information 350 (i.e., particular version information 255, FIG. 2). The web browser 152 may be also stored in the data storage device 330 and loaded 10 into the RAM 335 for execution. The bookmark folder 144 may be stored in the data storage device 330. As stated above with reference to FIG. 1, the base system 146 operates to synchronize the workspace data 136 (which includes the bookmark folder 144) with the workspace data 120. The base system 146 may be also stored in the data storage device 330 15 and loaded into the RAM 335 for execution.

20 FIG. 4 is a block diagram illustrating details of the base system 400, which exemplifies base systems 146 and 118. Base system 400 includes a communications module 25 405, a user interface module 410, locator modules 415, a synchronization-start ("synch-start") module 420, a general synchronization module 425 and a content-based synchronization module 430. For simplicity, each module is illustrated as communicating with one another 30 via a signal bus 440.

35 The communications module 405 includes routines for compressing data and routines for communicating via the communications interface 325 (FIG. 3) with the synchronization agent 124 (FIG. 1). The communications module 405 may further include routines for applying 40 Secure Socket Layer (SSL) technology and user identification and authentication techniques (i.e., digital certificates) to establish a secure communication channel through the global firewall 112. Examples of communications modules 405 may include TCP/IP stacks or the AppleTalk<sup>®</sup> protocol.

45 The user interface module 410 includes routines for communicating with a user, and may include a conventional Graphical User Interface (GUI). The user interface module 410 cooperates with the other system components as described herein.

50 The locator modules 415 include routines for identifying the memory locations of the workspace elements in the workspace data 136 or 116 and in the workspace data 120.

5                   Workspace element memory location identification may be implemented using intelligent  
software, i.e., preset memory addresses or the system's registry, or using dialogue boxes to  
query a user. More particularly, the locator modules 415 in the base system 146 determine  
10                  the memory addresses of the e-mail folder 138, the file folder 142, the calendar folder 140  
and the bookmark folder 144 and the memory addresses of the workspace elements therein.  
15                  The locator modules 415 also determine the corresponding memory addresses of the  
corresponding folders in the workspace data 120 and the corresponding workspace elements  
therein. Similarly, the locator modules 415 in the base system 118 determine the memory  
locations of the workspace elements of workspace data 116 and the memory locations of the  
20                  corresponding workspace elements in the workspace data 120.

It will be appreciated that the locator modules 415 may include locator modules 415  
specifically dedicated to each folder or workspace data type. That is, the locator modules 415  
25                  may include a locator module 415 dedicated to locating bookmarks, a locator module 415  
dedicated to locating e-mails, a locator module 415 dedicated to locating files, a locator  
module 415 dedicated to locating calendar appointments, etc. It will be further appreciated  
30                  that the locator modules 415 may perform workspace element memory location identification  
upon system boot-up or after each communication with the global server 120 to maintain  
updated memory addresses of workspace elements.

35                  The synchronization-start module 420 includes routines for determining when to  
initiate synchronization of workspace data 136 or 116 with workspace data 120. For  
example, the synchronization-start module 420 may initiate data synchronization upon user  
40                  request, at a particular time of day, after a predetermined time period passes, after a  
predetermined number of changes, after a user action such as user log-off or upon like  
criteria. The synchronization-start module 420 initiates data synchronization by instructing  
45                  the general synchronization module 425 (described below) to begin execution of its routines.  
It will be appreciated that communication with the synchronization agent 124 preferably  
initiates from within the LAN 110, because the typical firewall 114 prevents in-bound  
communications and allows out-bound communications.

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5                   The general synchronization module 425 includes routines for receiving version  
information 148 for modified versions from the synchronization agent 124 (FIG. 1), and  
routines for examining the version information 255 or 150 against a last synchronization  
10                   signature 435 (such as a last synchronization date and time) to determine which versions have  
been modified. The general synchronization module 425 further includes routines for  
examining the version information 148 and the version information 255 or 150 to determine  
15                   if one or both versions of a particular workspace element or workspace element folder have  
been modified.

20                   Further, the general synchronization module 425 includes routines for performing an  
appropriate synchronizing responsive action. Appropriate synchronizing responsive actions  
may include, if only one version of a workspace element in workspace data 136 or 116 has  
been modified, then forwarding the modified version (as the preferred version) to the other  
25                   store(s) or determining and forwarding only the changes made. Computing the changes made  
may be performed by examining the current status against the previous status as of the last  
synchronization or by comparing the two versions. It will be appreciated that no content-  
30                   based review of the changes is needed. It will be appreciated that one store preferably  
forwards only the changes to the other store for optimizing use of processor power and  
minimizing the data communications across the communications channel 108 or 104.

35                   Other appropriate synchronizing responsive actions may include, if two versions of a  
workspace element have been modified independently, then instructing the content-based  
synchronization module 430 (described below) to execute its routines. That is, if two  
40                   versions of the same workspace element have been modified independently, then a content-  
based review of the changes is preferable. Upon completion of the data synchronization, the  
general synchronization module 425 updates the last synchronization signature 435.

45                   The content-based synchronization module 430 includes routines for reconciling two  
or more modified versions of a workspace element. For example, if a user has independently  
modified the original and the copy of a workspace element since the last synchronization,  
50                   then the content-based synchronization module 430 determines an appropriate responsive

5 action. The content-based synchronization module 430 may request the user to select a  
preferred one of the modified versions or may respond based on preset preferences, i.e., by  
storing both versions in both stores or preferably by integrating the modified versions into a  
10 single preferred version which replaces each modified version at both stores.

15 The content-based synchronization module 430 examines the changes made to each  
version and determines if conflicts exist. When implementing version integration, a conflict  
may arise if inconsistent modifications such as deleting a paragraph in one version and  
20 modifying the same paragraph in the other version have been made. If a conflict exists, then  
the content-based synchronization module 430 attempts to reconcile the conflict, e.g., by  
requesting user selection or by storing both versions at both stores. Otherwise, if no conflict  
exists, then the content-based synchronization module 430 integrates the changes to each of  
25 the versions and updates the version information 148, 150 or 255 accordingly.

30 FIG. 5 is a block diagram illustrating details of the synchronization agent 124, which  
includes a communications module 505 (similar to the communications module 405  
described above with reference to FIG. 4) and a general synchronization module 515 (similar  
35 to the general synchronization module 425 described above also with reference to FIG. 4).

40 The communications module 505 includes routines for compressing data, and routines  
for communicating via the communications channel 108 with the base system 146 or via the  
communications channel 104 with the base system 118. The communications module 505  
may further include routines for establishing a secure communications channel through the  
45 global firewall 112 and through the LAN firewall 114 with the communications module 405.

50 Similar to the general synchronization module 425, the general synchronization  
module 515 includes routines for examining the version information 148 and the last  
synchronization signature 435 (FIG. 4) to determine which versions have been modified and  
the changes made. It will be appreciated that the general synchronization module 515 may  
55 maintain its own last synchronization signature 435 copy (not shown) or may request the last  
synchronization signature 435 from the base system 146 or 118. The general synchronization

5 module 515 further includes routines for forwarding workspace data 120 determined to be  
modified to the general synchronization module 425, and routines for receiving preferred  
versions of workspace elements of workspace data 136 or 116 or just the changes from the  
10 general synchronization module 425.

15 FIG. 6 illustrates an example bookmark workspace element in the global format. The  
global translator 122 incorporates all the information needed by both formats (Format A and  
Format B) to create the Global Format. For example, if a bookmark in Format A needs  
elements X, Y and Z and a bookmark in Format B needs elements W, X and Y, the global  
20 translator 122 incorporates elements W, X, Y and Z to create a bookmark in the Global  
Format. Further, the global translator 122 incorporates the information which is needed by  
the synchronization means such as the last modified date. Accordingly, a bookmark in the  
25 Global Format includes a user identification (ID) 605, an entry ID 610, a parent ID 615, a  
folder ID flag 620, a name 625, a description 630, the Uniform Resource Locator (URL) 635,  
the position 640, a deleted ID flag 645, a last modified date 650, a created date 655 and a  
30 separation ID flag 660.

35 FIG. 7 is a flowchart illustrating a method 700 for using a global translator 122 to  
synchronize multiple copies of a workspace element in a secure network 100. Method 700  
begins with the user interface module 410 in step 705 enabling a user to select workspace  
elements of workspace data 136 and 118 for the synchronization means to synchronize. The  
40 locator modules 415 in step 710 identify the memory locations of the workspace elements in  
workspace data 136 and 116 and the corresponding memory locations in workspace data 120.  
If a selected workspace element does not have a corresponding memory location, such as in  
45 the case of adding a new workspace elements to the global server 106, then one is selected.  
The selected memory location may be a preexisting workspace element or a new workspace  
element. As stated above, workspace element memory location identification may be  
50 implemented using intelligent software or dialogue boxes. The general synchronization

5 module 425 and general synchronization module 515 in step 715 set the previous status of the workspace elements equal to the null set. Setting the previous status to the null set indicates that all information of the workspace element has been added.

10 The synchronization-start module 420 in step 720 determines whether predetermined criteria have been met which indicate that synchronization of the workspace elements selected in step 705 should start. If not, then the synchronization-start module 420 in step 15 725 waits and loops back to step 720. Otherwise, the communications module 405 and communications module 505 in step 730 establish a secure communications channel therebetween.

20 The general synchronization module 425 and the general synchronization module 515 in step 735 determine whether any workspace elements have been modified. That is, the general synchronization module 425 in step 740 examines the version information 255 or 150 of each selected workspace element in the workspace data 136 or 116 against the last synchronization signature 435 to locate modified workspace elements. This comparison may include comparing the date of last modification with the date of last synchronization, or may 25 include a comparison between the current status and the previous status as of the last interaction. Similarly, the general synchronization module 515 examines the version 30 information 148 of each corresponding workspace element in workspace data 120 and the last synchronization signature 435 to locate modified workspace elements.

35 If in step 735 no modified workspace elements or folders are located, then the general synchronization modules 425 and 515 in step 760 update the last synchronization signature 435 and method 700 ends. Otherwise, the general synchronization module 425 in step 740 40 determines whether more than one version of a workspace element has been modified since the last synchronization.

45 If only one version has been modified, then the corresponding general synchronization module 425 or 515 in step 745 determines the changes made. As stated above, determining the changes made may be implemented by comparing the current status of the workspace 50 element against the previous status of the workspace element as of the last interaction

5 therebetween. If the changes were made only to the version in the workspace data 120, then  
the global translator 122 in step 750 translates the changes to the format used by the other  
store, and the general synchronization module 515 in step 755 forwards the translated  
10 changes to the general synchronization module 425 for updating the outdated workspace  
element in the workspace data 136 or 116. If the updated version is a workspace element in  
the workspace data 136 or 116, then the general synchronization module 425 sends the  
15 changes to the updated version to the global translator 122 for translation and then to the  
general synchronization module 515 for updating the outdated workspace element in the  
workspace data 120. The general synchronization module 425 and the general  
synchronization module 515 in step 757 update the previous state of to reflect the current  
20 state as of this interaction. Method 700 then returns to step 735.

25 If the general synchronization module 425 in step 740 determines that multiple  
versions have been modified, then the general synchronization module 425 in step 765  
computes the changes to each version and in step 770 instructs the content-based  
30 synchronization module 430 to examine content to determine if any conflicts exist. For  
example, the content-based synchronization module 430 may determine that a conflict exists  
if a user deletes a paragraph in one version and modifies the same paragraph in another  
version. The content-based synchronization module 430 may determine that a conflict does  
35 not exist if a user deletes different paragraphs in each version. If no conflict is found, then  
method 700 jumps to step 750 for translating and forwarding the changes in each version to  
the other store. However, if a conflict is found, then the content-based synchronization  
40 module 430 in step 775 reconciles the modified versions. As stated above, reconciliation may  
include requesting instructions from the user or based on preselected preferences performing  
responsive actions such as storing both versions at both stores. Method 700 then proceeds to  
45 step 750.

50 It will be appreciated that in step 710 new workspace elements and preexisting  
workspace elements to which new workspace elements will be merged are set to "modified"  
and the previous status is set to the null set. Thus, the general synchronization module 425 in

5 step 740 will determine that more than one version has been modified and the content-based synchronization module 430 in step 770 will determine that no conflict exists. The changes in each will be translated and forwarded to the other store. Accordingly, the two versions will  
10 be effectively merged and stored at each store.

For example, if a first bookmark folder was created by the web browser 152 on the desktop computer 134, a second folder was created by a web browser (not shown) on the remote terminal 102, no preexisting folder existed on the global server 106 and the user selected each of these folders for synchronization, then the synchronization means will effectively merge the first and second folders. That is, the general synchronization module 425 on the desktop computer 134 will determine that the first folder has been modified and the previous status is equal to the null set. The general synchronization module 425 will determine and send the changes, i.e., all the workspace elements in the first folder, to a new global folder on the global server 106. Similarly, the general synchronization module 425 on the remote terminal 102 will determine that, as of its last interaction, the previous status of each of the second and the global folders is the null set. The general synchronization module 425 will instruct the content-based synchronization module 430 to examine the changes made to each folder to determine whether a conflict exists. Since no conflicts will exist, the general synchronization module 425 will forward the changes to the global folder and the general synchronization module 515 will forward its changes to the second store, thereby merging the workspace elements of the first and second folders in the global and second folders. The general synchronization module 515 will inform the general synchronization module 425 that the global folder has been modified relative to the last interaction, and will forward the new changes to the first folder. Thus, the first and second folders will be merged and stored at each store.

45 For a second example, the user may select an exemplary document in the LAN 110 to be synchronized. The general synchronization module 425 will forward the document to the global server 106. Similarly, the user may select the same document for synchronization on the remote terminal 102. The general synchronization module 515 will forward the document  
50

5 to the remote terminal 102. If changes were made to the documents independently, then the  
content-based synchronization module 430 will examine the content of the documents to  
determine if a conflict exists. If no conflict exists, then as described above, the general  
10 synchronization modules 425 and 515 will merge the documents. Otherwise, if a conflict  
does exist, the content-based synchronization module 430 will reconcile the changes and then  
the general synchronization modules 425 and 515 will forward the reconciled changes to each  
15 other.

20 The foregoing description of the preferred embodiments of the invention is by way of  
example only, and other variations of the above-described embodiments and methods are  
provided by the present invention. For example, although the global server 106 is illustrated  
as a single device, the global server 106 may include several computers networked together.  
25 Components of this invention may be implemented using a programmed general purpose  
digital computer, using application specific integrated circuits, or using a network of  
interconnected conventional components and circuits. The embodiments described herein  
30 have been presented for purposes of illustration and are not intended to be exhaustive or  
limiting. Many variations and modifications are possible in light of the foregoing teaching.  
The system is limited only by the following claims.

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**Claims**

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WHAT IS CLAIMED IS:

1. A system, comprising:
  - a first store for storing a first workspace element in a first format;
  - a second store for storing a second workspace element which is an independently-modifiable copy of the first workspace element in a second format;
  - a communications channel coupling the first store to the second store;
  - synchronization means for synchronizing the first workspace element and the second workspace element; and
  - a translator for translating between the first format and the second format.
2. The system of claim 1, wherein the first format is the same as the second format.
3. The system of claim 1 wherein the second format includes HTML.
4. The system of claim 1, wherein the first store is in a LAN.
5. The system of claim 1, further comprising a firewall for protecting the first store.
6. The system of claim 1, further comprising a firewall for protecting the second store.
7. The system of claim 1, wherein the synchronization means includes
  - a first general synchronization module for examining the first workspace element at the first store to determine whether it has been modified; and
  - a second general synchronization module for examining the second workspace element at the second store to determine whether it has been modified.
8. The system of claim 7, wherein
  - the first workspace element and the second workspace element each include version information; and
  - the first and second general synchronization modules each examine the version information of each workspace element to a last synchronization signature to determine whether the workspace element was modified.
9. The system of claim 1, wherein the synchronization means includes a synchronization-start module for determining when to initiate synchronization.

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5           10.    The system of claim 1, wherein the first workspace element includes a first folder and the second workspace element includes a second folder.

10           11.    The system of claim 10, further comprising a content-based synchronization module for examining content of the first workspace element and of the second workspace element when the first workspace element and the second workspace element have both been modified since the last synchronization.

15           12.    The system of claim 11, wherein the content-based synchronization module determines if any conflicts exist, and if so then the content-based synchronization module reconciles the conflicts.

20           13.    The system of claim 11, wherein the content-based synchronization module determines if any conflicts exist, and if not then the content-based synchronization module integrates the changes made to each workspace element.

25           14.    The system of claim 1, further comprising a third store coupled to the second store for storing a third workspace element in a third format.

30           15.    The system of claim 14, wherein the translator translates between the second format and the third format.

35           16.    The system of claim 8, wherein the version information indicates the status of each workspace element as of the last synchronization.

40           17.    A method, comprising:  
                  accessing a first store storing a first workspace element in a first format;  
                  accessing a second store storing a second workspace element which is an independently-modifiable copy of the first workspace element in a second format;  
                  synchronizing the first workspace element and the second workspace element; and  
                  translating between the first format and the second format.

45           18.    The method of claim 17, wherein the first format is the same as the second format.

19.    The method of claim 17, wherein the second format includes HTML.

20.    The method of claim 17, wherein the first store is in a LAN.

21.    The method of claim 17, wherein the first store is protected by a firewall.

5            22. The method of claim 17, wherein the second store is protected by a firewall.

10            23. The method of claim 17, further comprising  
                  examining the first workspace element to determine whether it has been modified; and  
                  examining the second workspace element to determine whether it has been modified.

15            24. The method of claim 23,  
                  wherein the first workspace element and the second workspace element each include  
                  version information; and  
                  further comprising the step of comparing the version information of each workspace  
                  element to a last synchronization signature to determine whether the workspace element was  
20            modified.

25            25. The method of claim 17, further comprising the step of determining when to initiate  
                  synchronization.

30            26. The method of claim 17, wherein the first workspace element includes a first folder  
                  and the second workspace element includes a second folder.

35            27. The method of claim 26, further comprising the step of examining content of the first  
                  workspace element and of the second workspace element when the first workspace element  
                  and the second workspace element have both been modified since the last synchronization.

40            28. The method of claim 27, further comprising the step of determining if any conflicts  
                  exist, and if so then reconciling the conflicts.

45            29. The method of claim 27, further comprising the step of determining if any conflicts  
                  exist, and if not then integrating the changes made to each workspace element.

50            30. The method of claim 17, further comprising the step of accessing a third store  
                  coupled to the second store storing a third workspace element in a third format.

                  31. The method of claim 30, wherein further comprising the step of translating between  
                  the second format and the third format.

                  32. The method of claim 24, wherein the version information indicates the status of each  
                  workspace element as of the last synchronization.

                  33. A system, comprising:

5                   means for accessing a first store storing a first workspace element in a first format;  
                  means for accessing a second store storing a second workspace element which is an  
                  independently-modifiable copy of the first workspace element in a second format;  
10                  means for synchronizing the first workspace element and the second workspace  
                  element; and  
                  means for translating between the first format and the second format.

15                 34.    A computer-readable storage medium storing program code for causing a computer to  
                  perform the steps of:  
                  accessing a first store storing a first workspace element in a first format;  
                  accessing a second store storing a second workspace element which is an  
20                 5    independently-modifiable copy of the first workspace element in a second format;  
                  synchronizing the first workspace element and the second workspace element; and  
                  translating between the first format and the second format.

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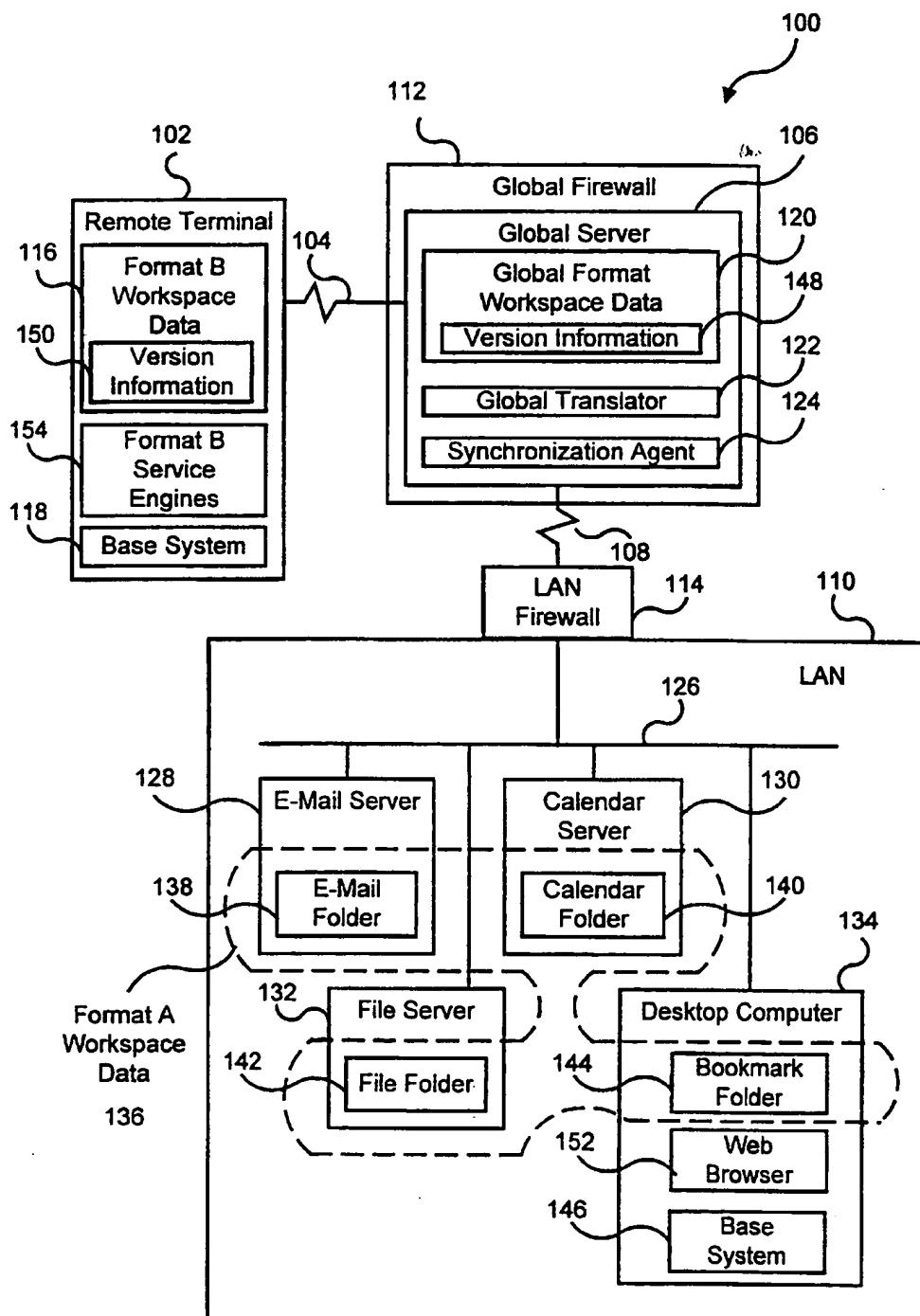


FIG. 1

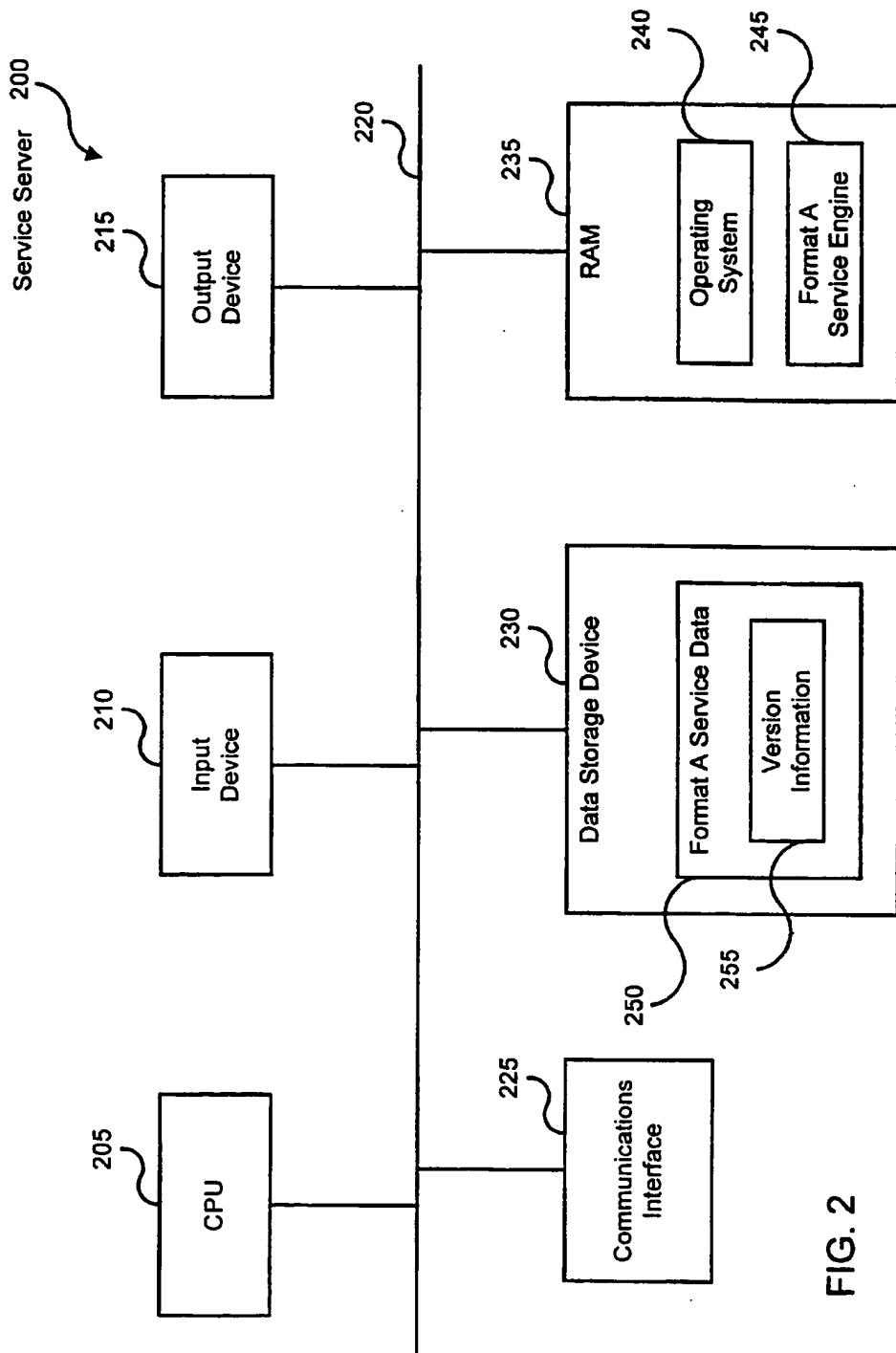


FIG. 2

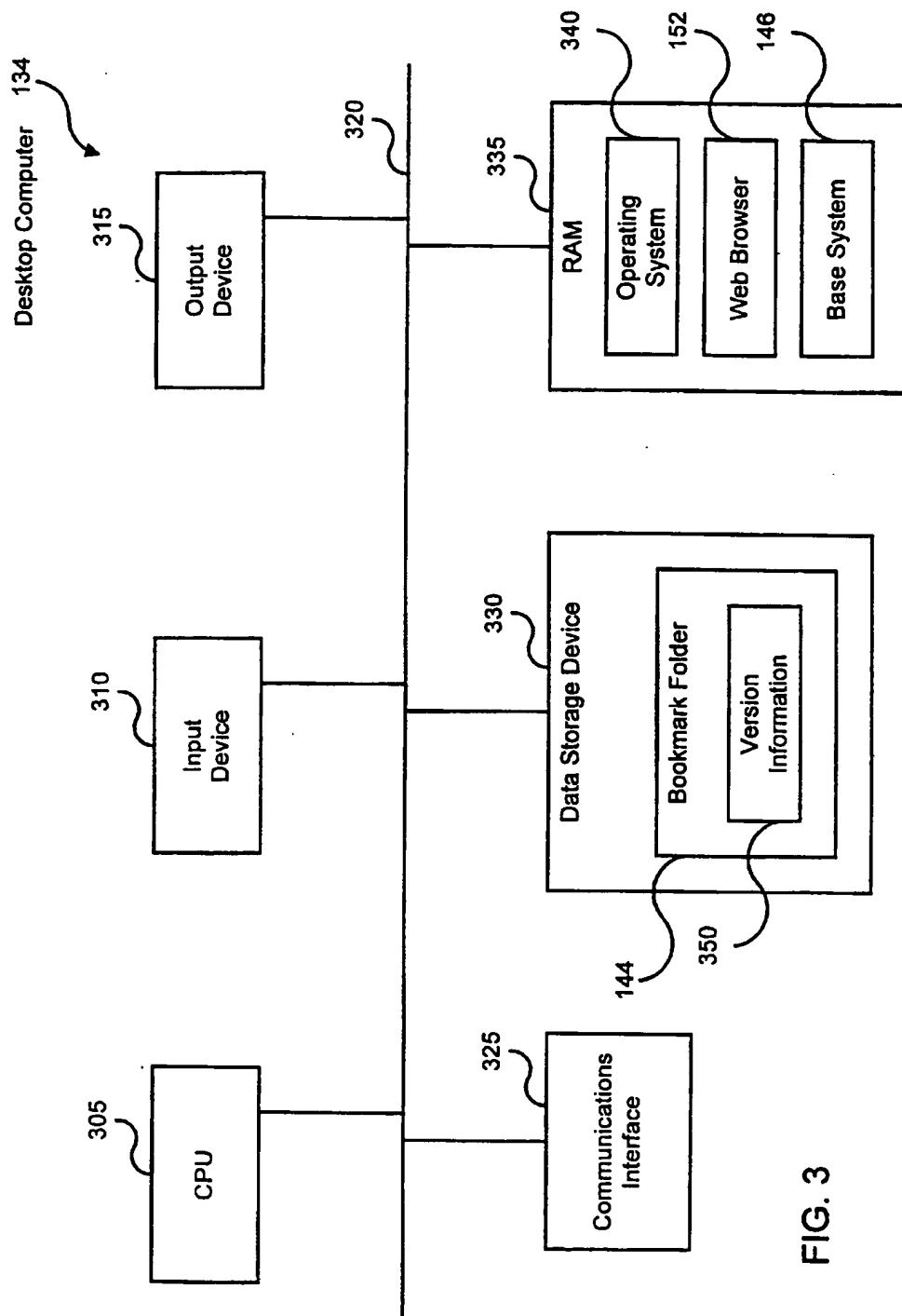


FIG. 3

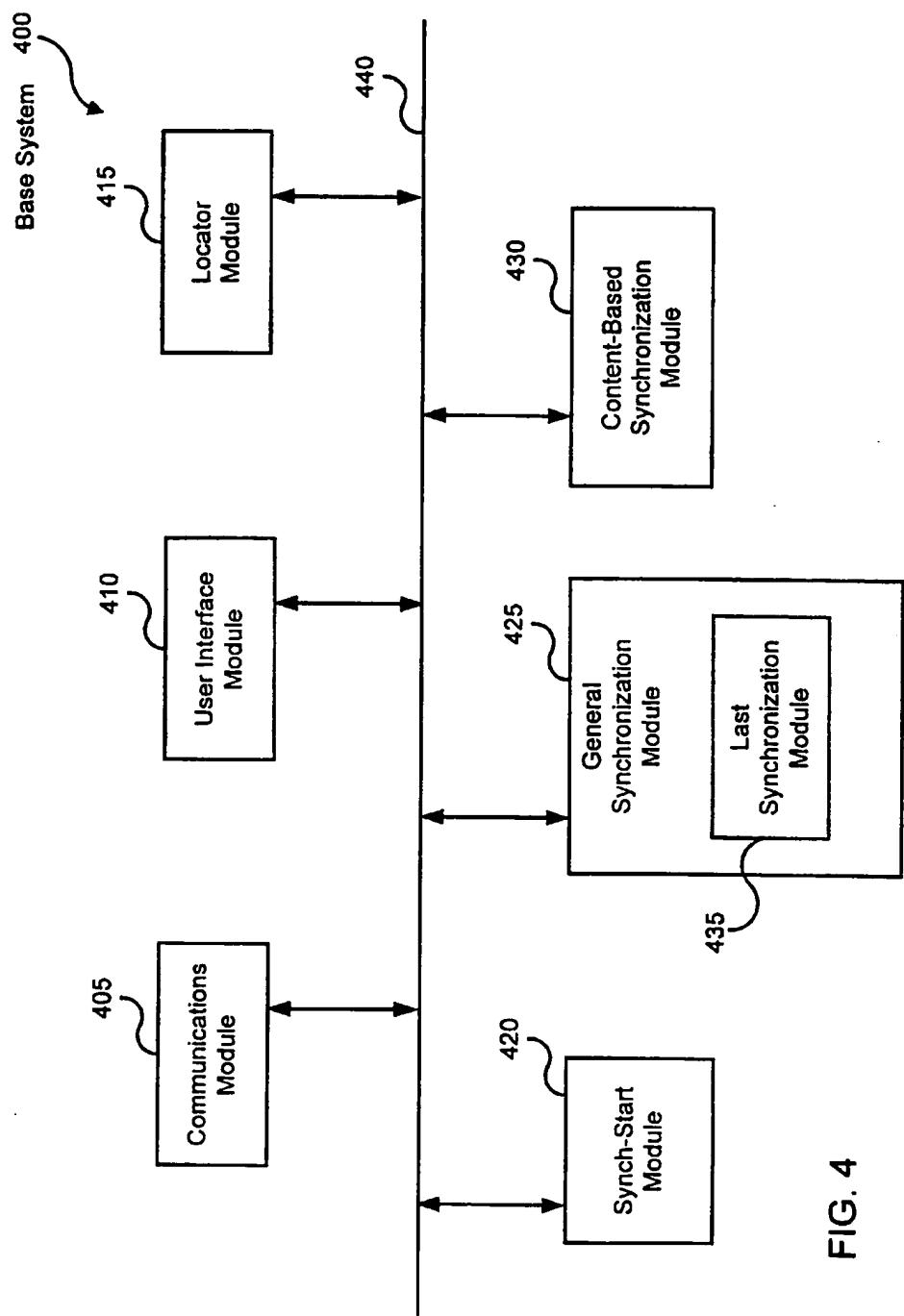


FIG. 4

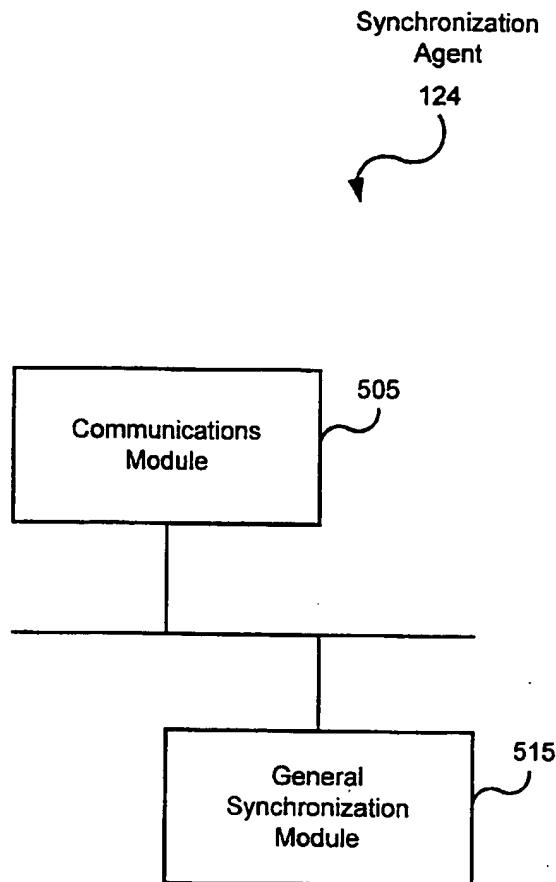
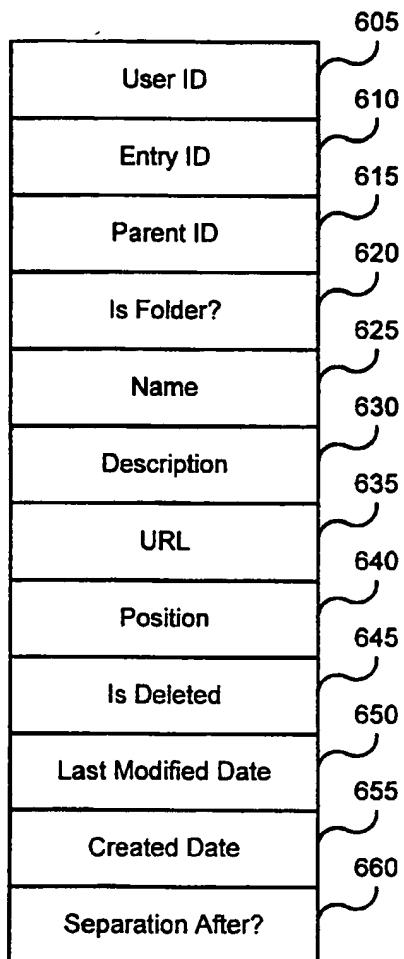


FIG. 5



**FIG. 6**  
**(Global Format Bookmark**  
**Example)**

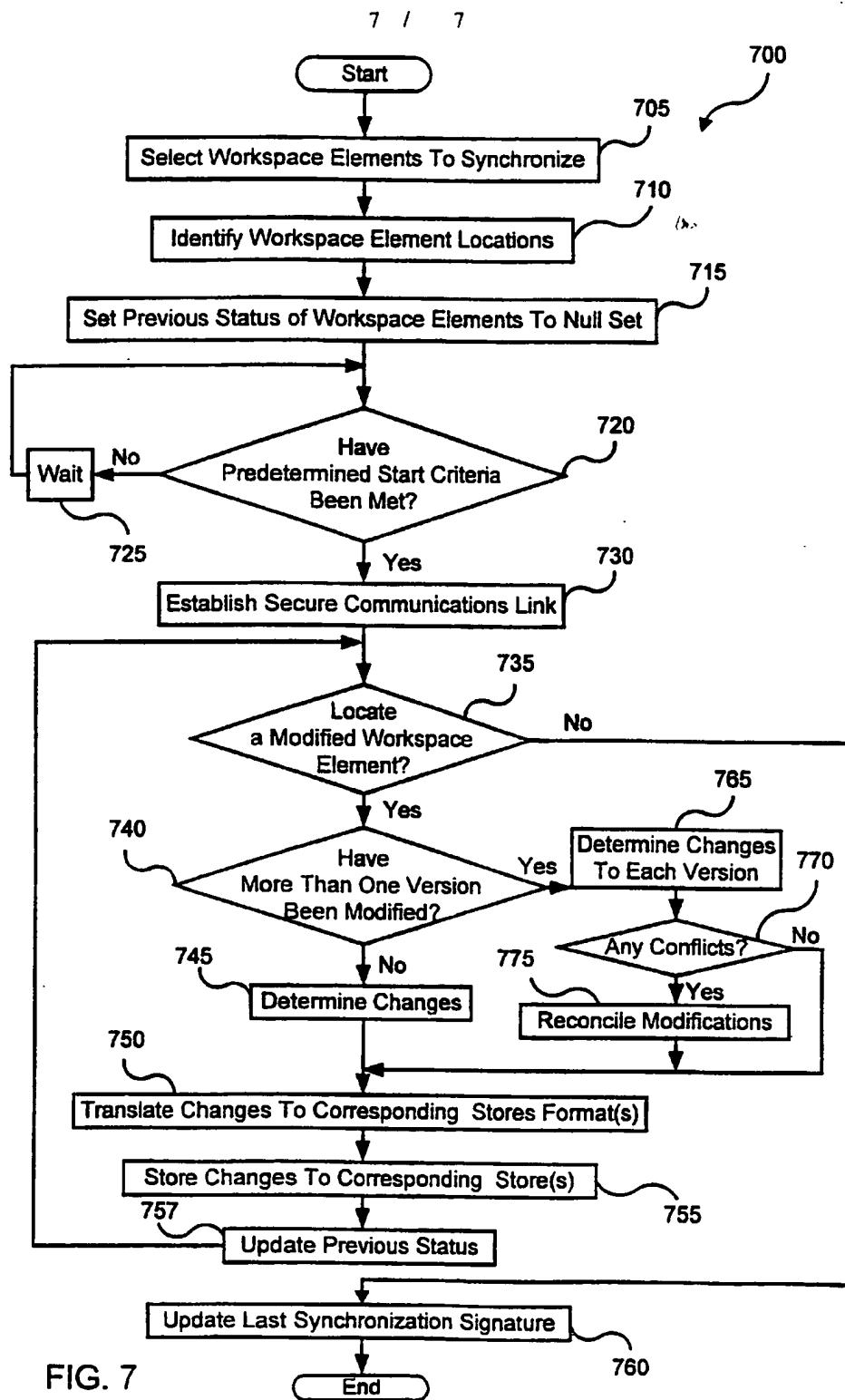


FIG. 7

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/17365

A. CLASSIFICATION OF SUBJECT MATTER		
IPC(6) :G06F 17/00 US CL :395/200.31 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) U.S. : 395/200.31, 200.78; 705/16, 21		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,745,360 A [LEONE ET AL.] 28 APRIL 1998, COLS 1-12.	1-34
Y	US 5,721,914 A [DEVRIES] 24 FEBRUARY 1998, COLS. 1-10.	1-34
Y	US 5,386,564 A [SHEARER ET AL.] 31 JANUARY 1995, COLS. 1-25.	1-34
Y	ENZO MARINACCI BOOKMARK TRANSLATOR 2.0 WWW.BNS.IT/EMWARE/BOOKMARKTRANSLATOR~UK.HTM JULY 1997, PAGES 1-4, SEE ENTIRE DOCUMENT.	1-34
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
<ul style="list-style-type: none"> <li>* Special categories of cited documents.</li> <li>*A* document defining the general state of the art which is not considered to be of particular relevance</li> <li>*B* earlier document published on or after the international filing date</li> <li>*L* document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</li> <li>*O* document referring to an oral disclosure, use, exhibition or other means</li> <li>*P* document published prior to the international filing date but later than the priority date claimed</li> </ul>		<ul style="list-style-type: none"> <li>*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</li> <li>*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</li> <li>*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</li> <li>*A* document member of the same patent family</li> </ul>
Date of the actual completion of the international search  25 SEPTEMBER 1998	Date of mailing of the international search report  03 NOV 1998	
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer Ellis B. Ramirez  Telephone No. (703) 305-9784	